# Single-Shell Tank Waste Stability

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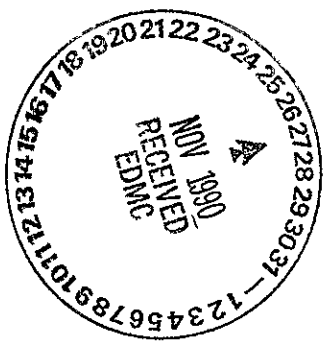


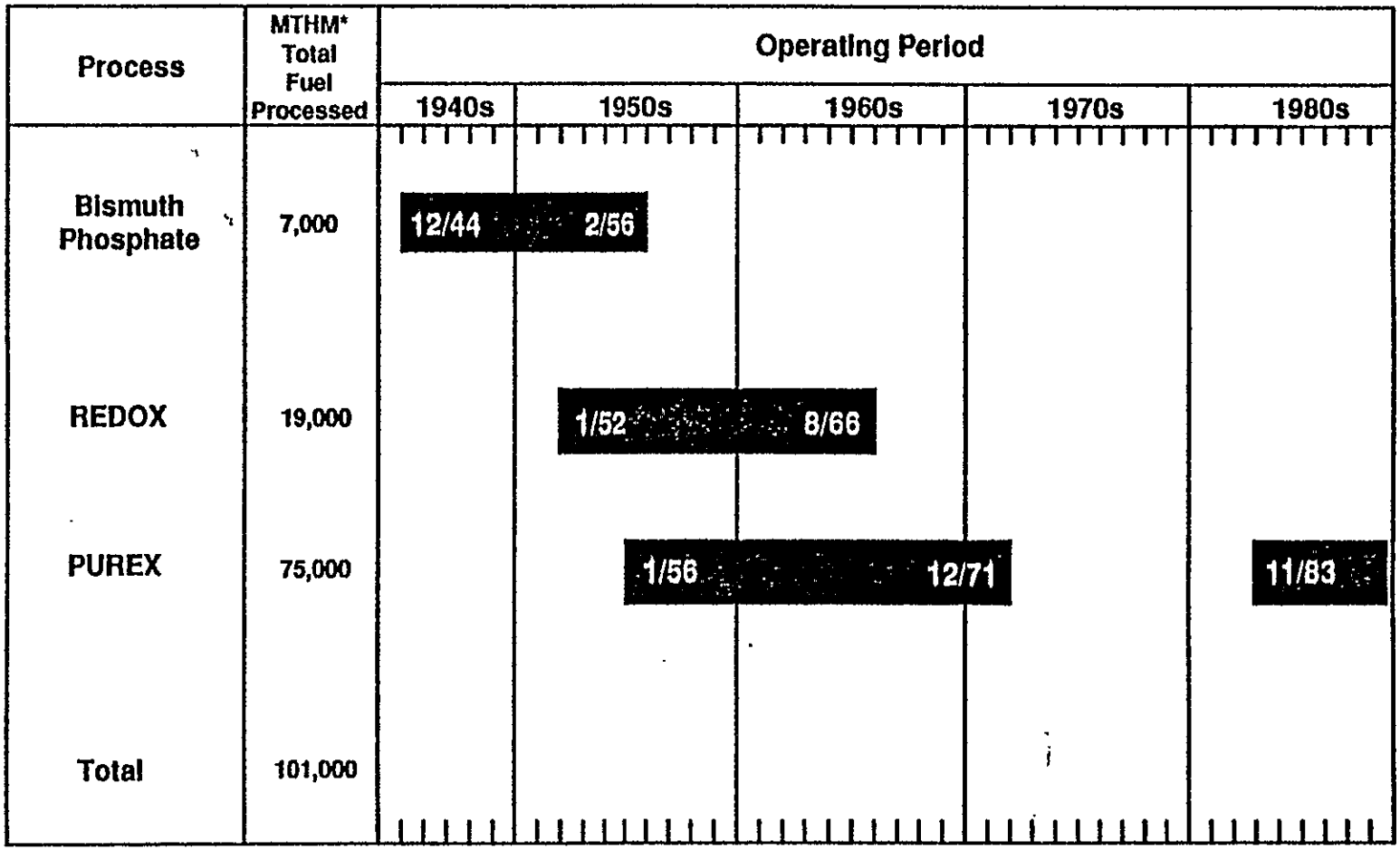
# Single-Shell Tank (SST) Waste Stability

## Agenda

- Processes that generated chemicals contained in Hanford Site SSTs
- Major chemicals of concern
- Potential reactions of concern
- Studies to evaluate explosion potential
- Kyshtym explosion
- Relevance of Kyshtym to Hanford Site SST Waste
- Summary and Conclusions

## Hanford Site Processes

# Primary Recovery Process




*Metric tons of heavy metal

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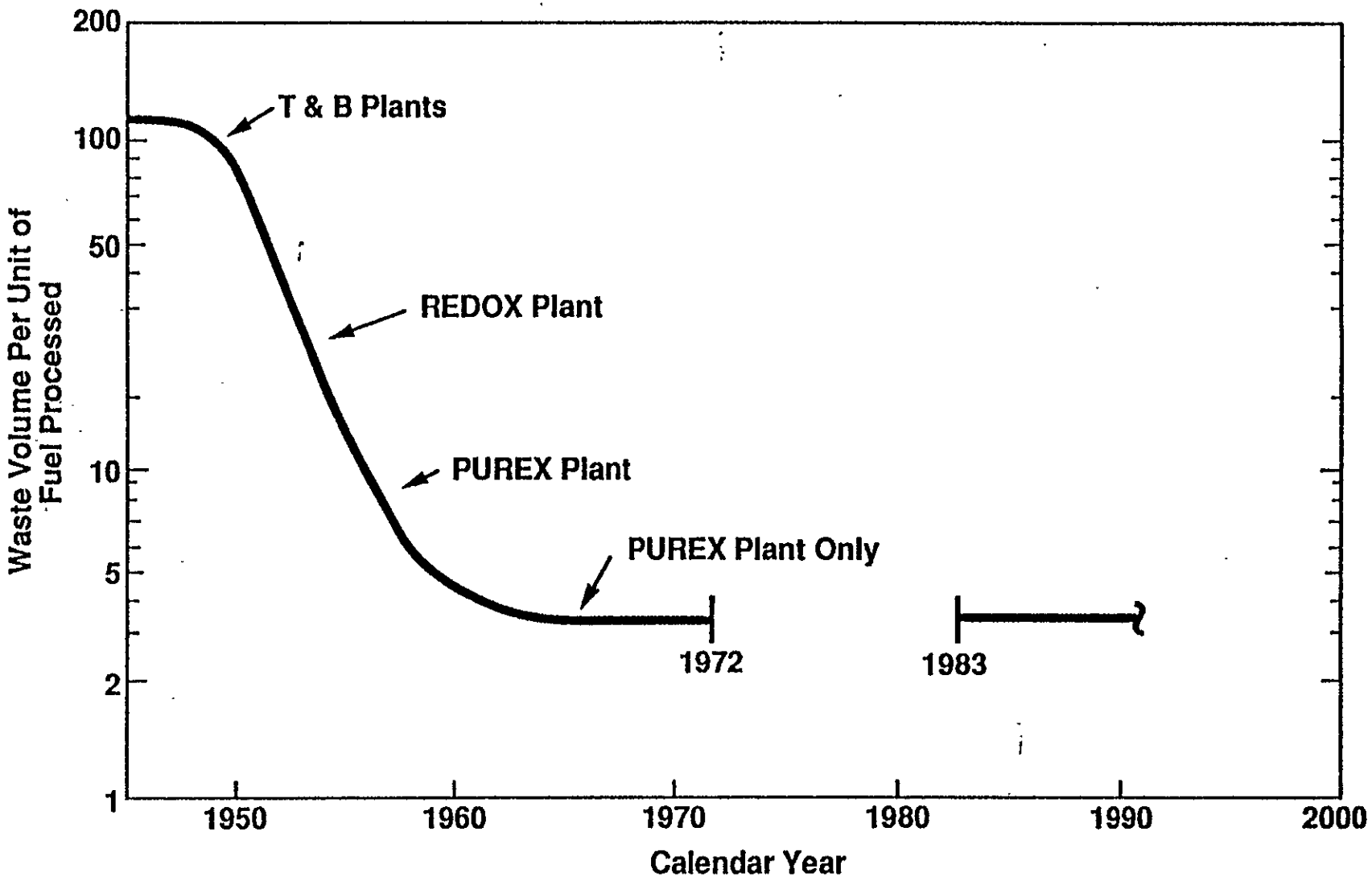
## Hanford Site Processes

# Waste Generator

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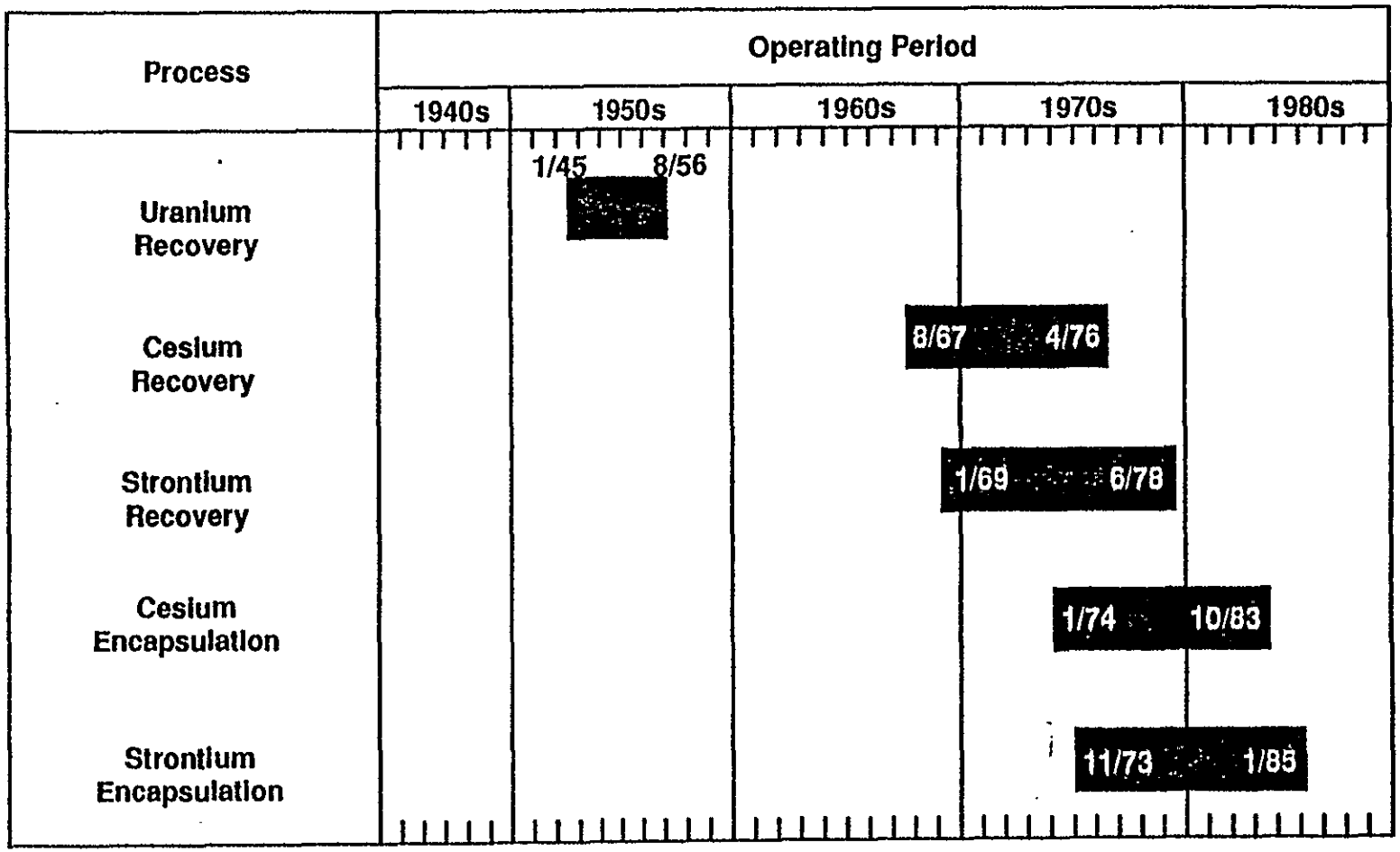
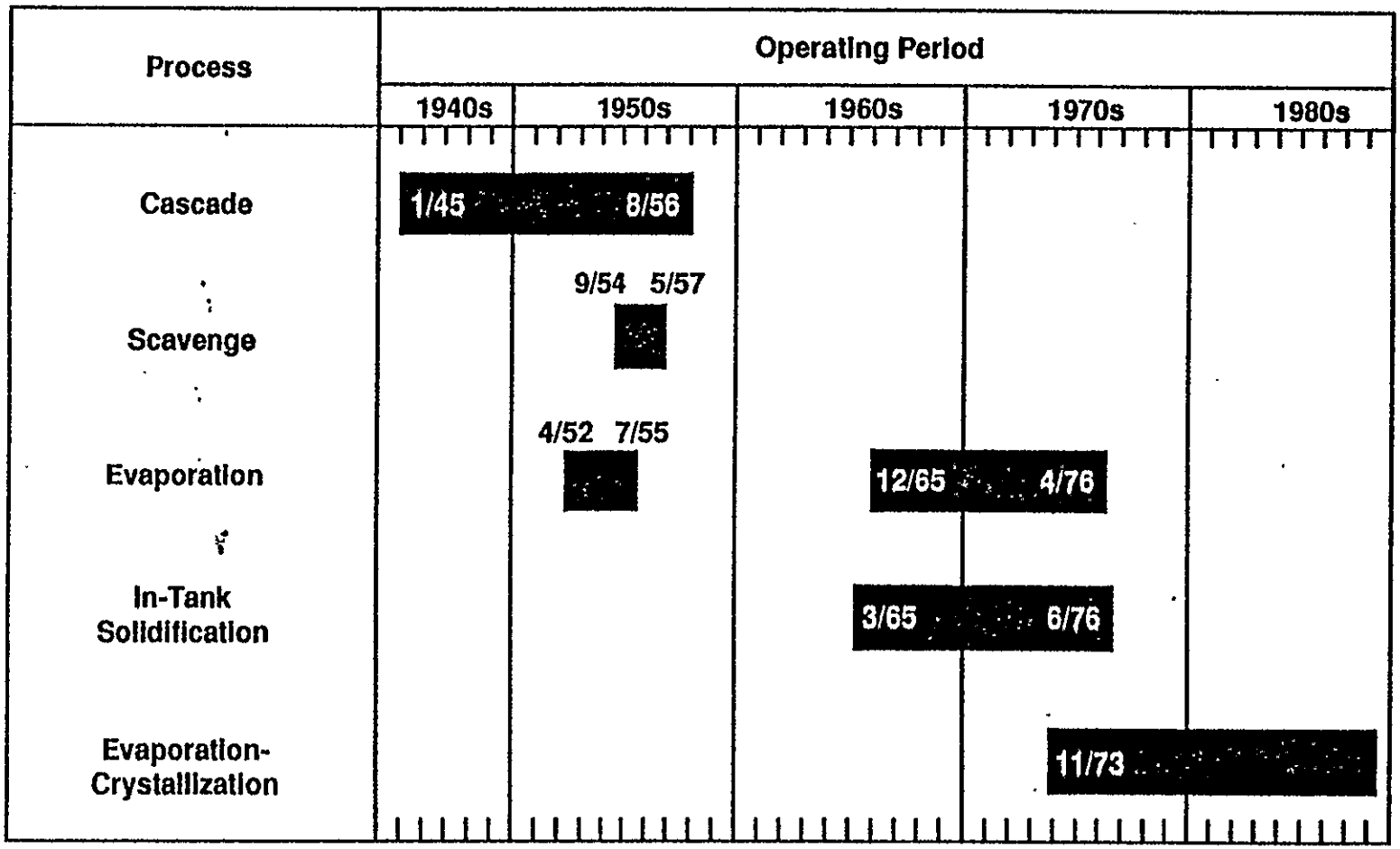
## Hanford Site Processes

# Secondary Recovery Process



## Hanford Site Processes

# Waste Management Process

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# Major Chemicals of Concern

## Bismuth Phosphate, REDOX, and PUREX

| | Classification |
|---|---|
| Ammonium Nitrate | Explosive |
| Organics Used (and Breakdown Products) | Reductants |
| Inorganic Nitrates and Nitrites | Oxidizers |

# Major Chemicals of Concern (cont)

**Other Sources:** Uranium and plutonium recovery, N Reactor operations, laboratories, waste fractionation and encapsulation, equipment decontamination, and waste scavenging

- Chemicals of concern--same as previous processes but in smaller amounts
- Exception--large amount of ferrocyanide (FeCN) used during scavenging process (22 tanks)

# Potential Reactions of Concern

- **Ammonium nitrate explosion**

  **All ammonium nitrate in waste destroyed because**
  $NH_4NO_3 + NaOH \rightarrow NaNO_3 + H_2O + NH_3 \uparrow$

- **Reduction-oxidation reactions**

{ Organics (breakdown products) or Ferrocyanide } + { Inorganic Nitrates and/or Nitrites }

# Studies to Evaluate Explosion Potential

| Event | Year |
|---|---|
| • Kyshtym Accident | 1957 |
| • Kyshtym Accident First Revealed | 1973 |
| • Nitrate and Organics Used (Rockwell Hanford Operations/ Hazards Research Institute [HRI]) | 1973-1977 |
| • Literature Review of FeCN Potential (Pacific Northwest Laboratory [PNL]) | 1983-1984 |
| • Literature Review of Organics Potential (PNL) | 1985 |
| • Laboratory Test of FeCN Potential (PNL) | 1988-1990 |
| • Kyshtym Accident Officially Confirmed | 1989 |
| • Evaluation of Kyshtym Event, and Relevance to Hanford Site Tanks (Westinghouse Hanford) | 1989-1990 |

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## Studies to Evaluate Explosion Potential

# Completed Studies

### Sodium Nitrate ($NaNO_3$) (Saltcake) and Organics

- Evaluation by HRI (1973-1977)
  - Laboratory studies on mixtures of sodium nitrate, saltcake, and major organic chemicals used at the Hanford Site
  - Reports issued in 1976 and 1977

- Conclusion
  - These mixtures are stable at temperatures below 480 °F. Current maximum reading in SSTs is approximately 230 °F.

## Studies to Evaluate Explosion Potential

# Completed Studies (cont)

### Organics

- Evaluation conducted by PNL (1985)
  - Literature review of organic explosives (fulminates, lead azide, phenolic compounds, polynitrated organics, nitrate esters, black powder explosives) and one inorganic explosive (ammonium nitrate)

- Conclusion
  - Operating conditions (i.e., alkaline, high moisture, low temperature) do not allow the presence of these explosives in the tanks.

## Studies to Evaluate Explosion Potential

# Studies in Progress

**FeCN + $NaNO_3$ or $NaNO_2$ (22 tanks)**

- **Laboratory testing by PNL and Los Alamos National Laboratory (1988-1990)**
- **Lowest reaction temperature observed (460 °F) is substantially higher than the maximum temperature measured in FeCN-containing tanks (134 °F)**

## Kyshtym Explosion

# History

- Waste tank explosion occurred on September 29, 1957
  - Contaminated large areas (primarily with $^{90}Sr$)
    - >15,000 $km^2$ to >0.1 Ci/$km^2$
    - 1,000 $km^2$ to >2 Ci/$km^2$
    - 120 $km^2$ to >100 Ci/$km^2$
  - 10,000 people evacuated

- Confirmed by USSR
  - TASS, June 17, 1989
  - Technical report through the International Atomic Energy Agency, July 26, 1989

Kyshtym Explosion

# History(cont)

- First revealed by Medvedev, geneticist exiled in 1973
- Event analyzed by
  - Prof. Frank L. Parker, Vanderbilt University, in 1978
  - Oak Ridge National Laboratory in 1979
  - Los Alamos National Laboratory in 1982

# Kyshtym Explosion
## Evaluation

- Chemical Explosion
  - Nitrate-acetate – most likely as mixed sodium saltcake
  - Cake dried by radiolytic heating months after cooling water system failure
  - Autoignition temperature ≥ 716 °F (i.e., decomposition of $NaNO_3$)
- Acetates probably introduced by chemical processing
- Cesium-rich supernatants apparently drawn off earlier

# Relevance of Kyshtym to Hanford Site SST Waste

**Chemicals that could react are present in SST waste**

- FeCN-$NaNO_3$
  - Lowest reaction temperature observed was 460 °F
  - FeCN tanks (22) are currently moist and cool (<135 °F)

- Organics – $NaNO_3$
  - Autoignition temperature of $NaNO_3$ is 716 °F
  - Explosion potential low at organic concentration of <5% in $NaNO_3$
  - SSTs are currently moist and cool (<230 °F)

# Summary and Conclusions

- Potential for chemical explosion in SSTs has been evaluated throughout the past 15 to 20 years
- Explosion or rapid reactions from the types of chemicals present in SSTs, in general, require ***both*** specific chemical mixtures ***and*** high temperatures
- Chemicals that could react are present in tanks ***but high temperatures are not*** present in tanks
- Studies in progress to further evaluate FeCN will be completed in 1990